PROGRESS REPORT
SUSCEPTIBILITY OF WHITE PINE STANDS TO INFESTATIONS OF THE MOUNTAIN PINE BEETLE

by
James C. Evenden, Senior Entomologist,* and
Tom T. Terrell, Senior Scientific Aide

INTRODUCTION

Infestations of the mountain pine beetle (Dendroctonus monticolae Hopk.) are to be found in all stands of commercial-sized white pine. In some areas these infestations are light and scattered and remain at the same level of intensity for years. Such situations are seldom noticed and the loss of white pine associated with them is of little economic importance. In other areas light infestations build to severe epidemics, destroying in a few years a large percent of the pine over extensive areas, which seriously affects plans of forest management. This variation in the behavior of mountain pine beetle infestations is an important consideration in directing artificial control.

Although the intensity of epidemic infestations can be satisfactorily reduced by direct control, there is no assurance of permanency in the results obtained. In some areas infestations start rebuilding to their former severity a year or two after control is conducted, while in others the results are more permanent. To combat persistent infestations, programs of maintenance control are necessary if serious losses are to be prevented. However, if areas are held under such programs for extended periods, the same devastation can eventually occur as would have happened had no maintenance control been conducted.

To avoid the expense and objections to direct control, one turns to hopes of preventing bark beetle outbreaks rather than controlling them. Differences in the vulnerability of white pine stands to bark beetle attack suggest possibilities in achieving this objective. If susceptible areas could be recognized, plans of direct control and

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* The title of junior author does not seem to portray the full significance of Mr. Terrell's part in this project. Although the senior author has taken the initiative in writing this report, he wishes to acknowledge and give full credit to Mr. Terrell for his painstaking work in obtaining and summarizing the data presented.

management could be adjusted to meet existing conditions. With this idea as a potential solution, a study of the susceptibility of white pine stands to infestations of the mountain pine beetle was instituted in 1940. As no special allotment of funds and no personnel were available for this project, it was necessary to sandwich field and office work in with other assigned projects. Although more data were desired, the information obtained is considered as being significant to the degree to which it is represented in this analysis.

STUDY OBJECTIVES

As white pine stands start with many thousands of small trees per acre, natural thinnings are necessary to adjust rapidly growing trees to the wood-producing capacity of the soil on which they stand. Trees killed by bark beetles are a part of this natural thinning which is essential in developing maximum stockings of commercial white pine. However, losses from insect attack which are subsequent to this development constitute a direct drain upon potential white pine yields. In addition to actual loss, this destruction of trees opens forest canopies to infiltration of associated shade-tolerant trees. This replacement of tree species is the first step in the natural succession of western white pine as described by Haig*.

To obtain full returns from forest lands, maximum crops of desired timber species must be grown in as short a rotation as possible. Minimizing losses from bark beetle attack is an important step in obtaining this objective. This step could be accomplished by harvesting all merchantable stands where insect damage balances the annual growth of white pine. In addition to obtaining maximum production, such action would simplify problems of silviculture and provide an early release of forest lands for additional crops. Although a solution, it is not a simple one, as such favorable stand conditions must be recognized and subsequent cuttings adjusted to both management and market conditions. In connection with this phase of our problem it is hoped that work instituted by the Northern Rocky Mountain Forest and Range Experiment Station relative to the economics of selective cutting of white pine can be continued to a logical conclusion. It is believed that if fully stocked stands could be thinned to a point below the wood-producing capacity of the soil, the residual stocking could be held for a number of years without extreme losses. In theory at least such thinning would involve only trees that would be destroyed during the subsequent period of years the stand was to be held. Obviously the effectiveness of such management depends upon an ability to make stand and tree classifications of insect susceptibility.

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* Haig, I. T., Davis, K. P., and Weidman, R. H.
1941. Natural Regenration in the Western White Pine Type.
U. S. Dept. Agr. Tech. Bull. 767.

PLAN OF OPERATION

In undertaking this problem it was realized that it would be impracticable for us to obtain data which would meet the requirements of all factors involved. Age, site, and stocking were considered as having the greatest relationship to this problem, although the importance of other environmental conditions was not overlooked. We realized the potentials of soils, but were obliged to utilize sites as indirect measurements of their wood-producing capacity. Stand composition was a factor of unknown value. Although closely related with stocking, it was realized that different stand compositions could contribute to the decadence of white pine.

Our field work was planned so as to obtain data upon the following stand conditions:

Age - 7 groups (80, 100, 120, 140, 160, 180, 200)

Site - 5 groups (Excellent, Good, Fair, Poor, Very Poor) *

Stocking - 3 groups (Light, Medium, and Heavy)

Our first data were taken from 1/5-acre plots, but in 1942 their size was increased to 1 acre. These plots were taken at regular intervals along projected lines which in the judgment of the officer in charge provided the best sample. Although an attempt was made to obtain all essential information, it is now realized that data concerning exposure, slope, and even a general soil description would have been of value.

To obtain an over-all picture of this problem, data were obtained from all white pine forests of Idaho and Montana. These data were watched carefully to obtain a proper representation of the factors involved. This was not a simple task, as it was soon found that such ideally balanced field conditions did not exist. It was also found that the white pine areas of the region varied in their productivity. This variation supported the accepted contention that optimum conditions for the growing of this tree species occur in the southern portions of the Idaho white pine area, with less favorable conditions to the north. Although the data obtained were accepted as a sample of average conditions for the entire area, they were not in sufficient quantity to permit a "breakdown" into area variables.

GENERAL CONSIDERATION OF DATA

Although this study was predicated upon certain assumed principles, it was realized that there could be no assurance of the actual trends

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* These five groups were subsequently changed to three.

which the data would take. In fact, as will be shown, there was little justification for some of these assumptions.

Data as to the loss of white pine from insect attack was obtained from the standing snags of insect-killed trees. This loss was assigned to a period of 15 to 20 years, which was considered as the average time such snags would remain standing. As exposure, elevation, soils, and tree sizes all influence the rate of snag fall, we were unable to provide a more definite time period.

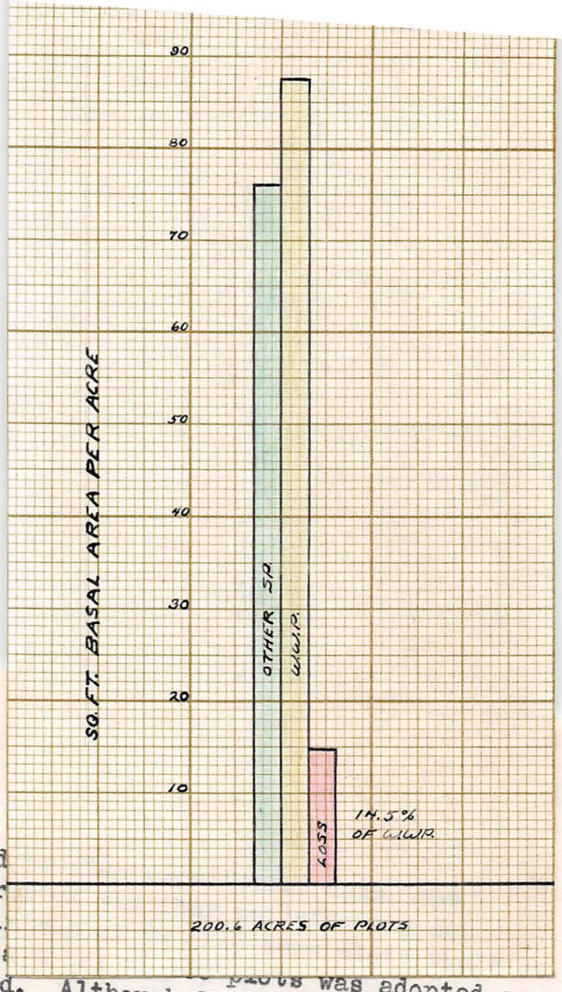
Small plots were used to provide data as a part of the total sample to be taken from each universe. Obviously the standard deviation of the mean of such plots is high, but when an adequate sample is obtained, its percent of error is considered as acceptable. This variation in the plots for different age classes is shown in the following tabulation:

Table 1 - Significance of loss data for different age classes

(Loss data shown in square feet of basal area)

Age class	Number of 1/5-acre plots	Mean insect loss		Standard deviation	Standard error	Percent of error
80	40	2.20	±	4.20	.66	30
90	33	1.80		3.58	.62	34
100	98	2.65		3.75	.36	13
110	190	3.05		4.24	.31	10
120	152	2.89		4.04	.29	10
130	129	2.63		3.68	.24	9
140	52	2.16		2.82	.39	18
150	48	2.03		3.33	.48	23
160	55	3.72		5.10	.69	18
170	54	2.19		2.70	.37	17
180	55	4.47		7.12	.96	21
190	53	6.99		9.17	1.59	22
200	24	3.70		5.91	1.21	32
200+	147	2.57		4.26	.35	15

As would be expected from such a marked variable as insect damage in white pine, the loss data show only an average for each age class. As some variation in the true significance of samples must be accepted, an error of 15 percent was adopted as allowable. In the 100-130 year age classes inclusive, the standard error of sampling was sufficiently low to give acceptable significance to the "mean insect loss".



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This report is limited to an overall picture of the problem, with no definite conclusions drawn. Furthermore, we make no claims for the deductions or explanations - they are as we see our data at this time.

RELATION OF INSECT LOSS TO AVERAGE STAND IN WHITE PINE AREA

Chart 1 and its purpose in this report are self-explanatory. The insect loss and the stand-per-acre figures are averages of all white pine stands within the region. The figures are supported by adequate, well-distributed data, which make the totals fully significant.

Obviously the relation of these items to each other will vary for individual stand conditions and for different areas. However, these data for the entire area provide a standard for subsequent comparisons.

RELATION OF INSECT LOSS TO AVERAGE FOREST SITES IN WHITE PINE AREA

Height growth over age, upon which site classifications are

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* $\left(\frac{S.D.}{SE}\right)^2 = \left(\frac{3.89}{.42}\right)^2 = 9.3^2 = 86$ plots

To determine the sample which would provide significant data, the standard deviation and standard error of the four satisfactory age classes were used to show that a minimum of 86 1/5-acre plots would be necessary*. As a margin of safety a total of 100 plots was adopted as a standard for each universe sampled. Although 1185 data plots were obtained, 35 of them were in a young (60-year) age class and 147 in old (200+) stands of uncertain age, and were rejected from this analysis.

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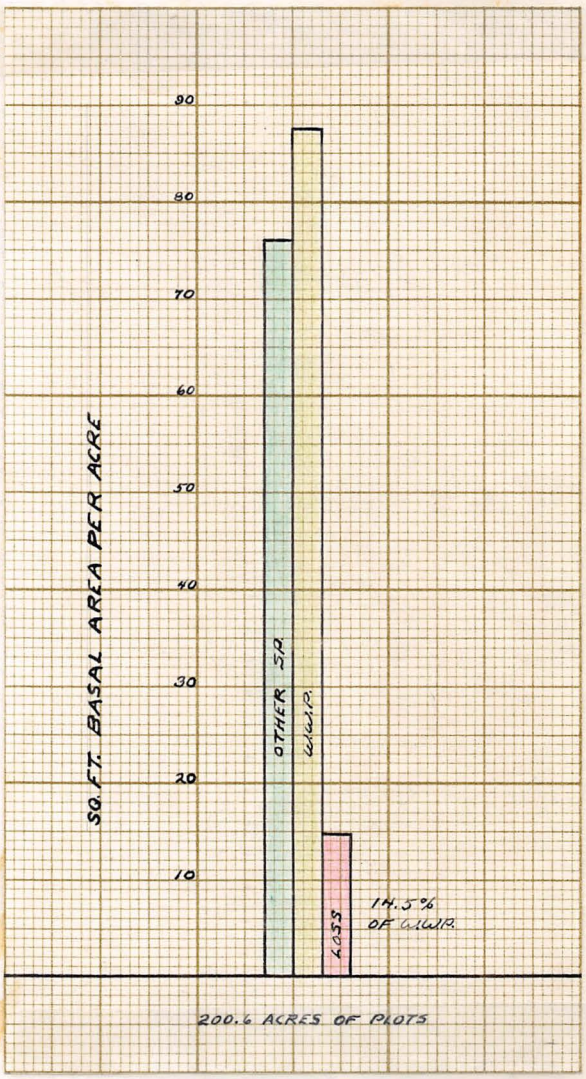

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based, is accepted as a practical measure of the wood-producing capacity of forest soils. However, forest sites are complex relationships, and in making a full evaluation consideration should be given also to such evident factors as exposure, slope, soil composition, and moisture. Although present methods of site classification offer gradations of existing timber stands, they do not portray soil potentials.

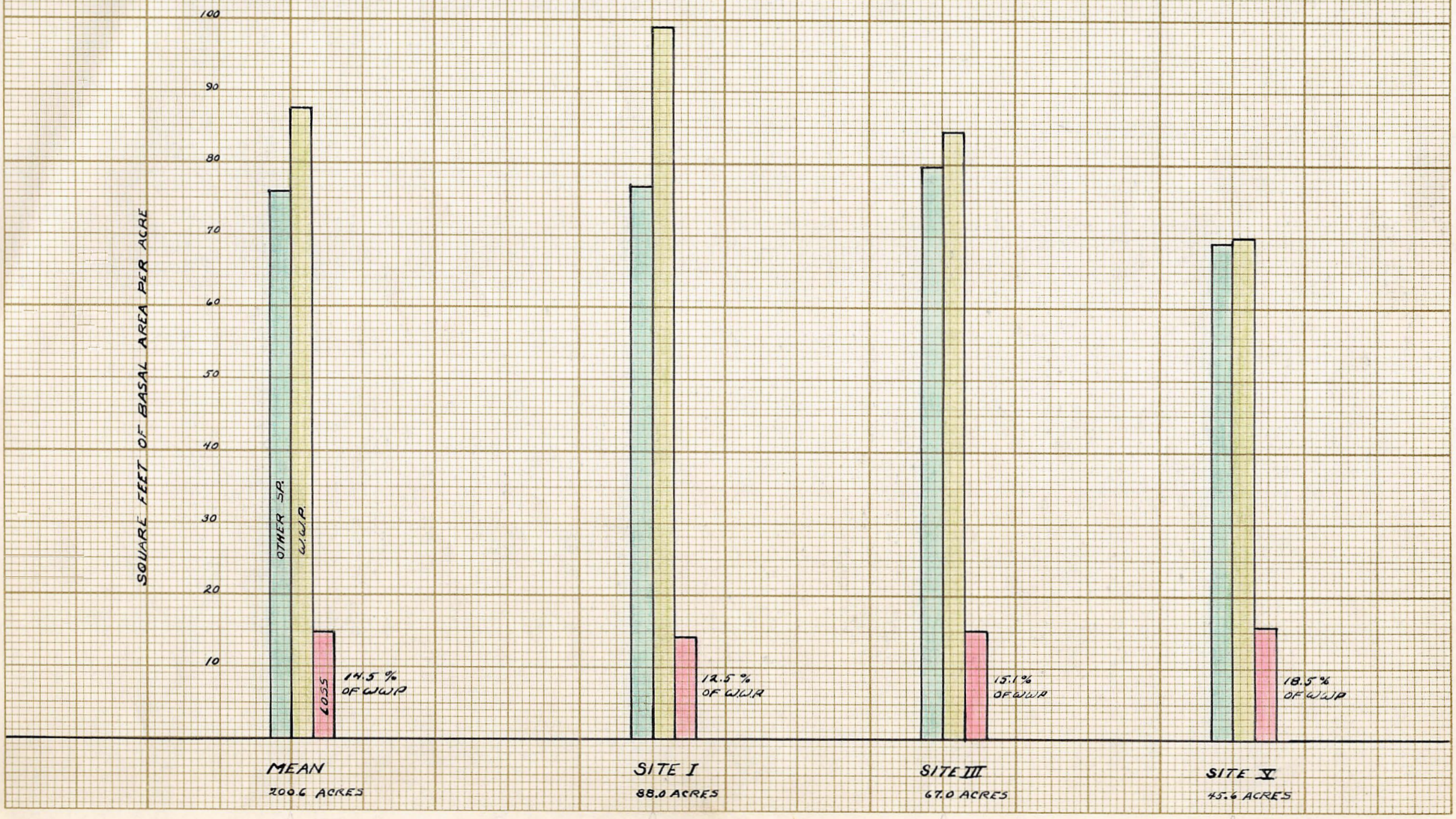
In chart II the 200.6 acres of plot data are presented in three site classifications in lieu of the conventional five groups. This procedure was adopted to eliminate borderline areas and to provide a better representation of the data obtained. In this arrangement the conventional Forest Service 1 and 2 classifications are placed in site I; site III is the same as the Forest Service site 3, while site V includes the 4 and 5 groupings. In this presentation the variables of age, stocking, and stand composition are held constant. It will be seen that the stand picture as portrayed for site III is quite comparable to the average of the entire area. This similarity would be expected, as in reality sites depict rather average forest condition, with all age classes, sites, stockings, etc., represented. In younger stands the volume of white pine will most often exceed that of the associated mixed species, while in older stands this condition is reversed. The value of height growth as indicating the wood-producing capacity of forest soils is supported by these data.

Although the actual volume of white pine destroyed by insects on these three sites is practically the same, it is obvious that with different pine volumes represented the percentage of pine will vary proportionately. On site I only 12.5% of the white pine stand was destroyed, while on sites III and V the loss increased to 15.1% and 18.5% respectively. As sites depict average forest conditions, it is not difficult to understand why the actual white pine loss should be the same in all three classifications.

In considering the susceptibility of forest trees to bark beetle attack, either as individuals or in timber stands, it has been assumed that the most vigorous are the most resistant. By the same token one might assume that sites which produce the greatest volume of timber likewise produce vigorous trees, and that such areas can be classed as resistant to beetle attack. Such an analogy is not true. Timber volumes indicate what has been grown on an area during a variable period of years. Although in most instances larger volumes of timber are produced on the better sites, the timber stands are only as vigorous as the wood-producing capacity of the soil will permit. Site should not be considered as indicating vigor, but the volume of wood that has been grown.

CHART II

RELATION OF OTHER TIMBER SPECIES, W.W.P., & INSECT LOSS BY FOREST SITES



RELATION OF INSECT LOSS TO DEGREE OF AVERAGE STOCKING IN WHITE PINE AREA

There are two ways in which stand densities could be related to insect loss. White pine trees in overstocked stands could be of low vigor and consequently susceptible to bark beetle attack. There is also a possibility that the number of trees available influences the chances of attacks - for example, lots of trees, lots of attacks. In determining the possibility of these relationships our data were divided into three degrees of stocking, which varied for different age classes. An adjustment for age was necessary, as it was obvious that the basal area of a light stocking in an 80-year stand would be less than that of a light stocking in a 160-year age class. These age groupings were obtained by first plotting a scattergraph of the stocking of a few well-represented age classes. From these graphs the midpoints and limits of each degree of stocking were determined arithmetically. The adjustment of these specific data to all age classes was made by comparison to standard volume tables.

In chart III stand and loss data for all white pine areas are presented in three degrees of stocking. The "Light Stocking" is the average of light stockings for all age classes, and so on. Although all age groups are represented in each stocking, they are not in equal proportion, as our data were not equally balanced. As would be expected, the data shown for the medium stocking are quite comparable to the average stand and loss figures of the entire area (chart I). As this similarity also existed with the data as shown for site III in chart II, it is apparent that the mid-groupings of site and stocking are significant averages of each general classification.

These data show the basal area loss of white pine to be greater in the heavier stocking, with the percent of loss practically the same for each group. As a check upon this relationship the site classification data as shown in chart II were subdivided into three degrees of stocking. Although some of these subdivisions do not have sufficient supporting data, the same trend is shown in all instances.

In these stocking classifications, stand, age, and composition, sites, exposure, etc., are rather equally represented, which tends to produce an average forest condition for each group, with stocking as the only variable. The relation of this variable to loss would seem to be sufficiently strong to offset the tendency of a loss comparable to the average for the area. The fact that the percent of white pine destroyed is practically the same for each stocking would seem to support the position that other factors involved are equal.

It will be recalled that this insect loss-stocking relationship was not apparent in the different stockings of site classification.

CHART III

RELATION OF OTHER TIMBER SPECIES, WWP, AND INJECT LOSS BY STOCKING

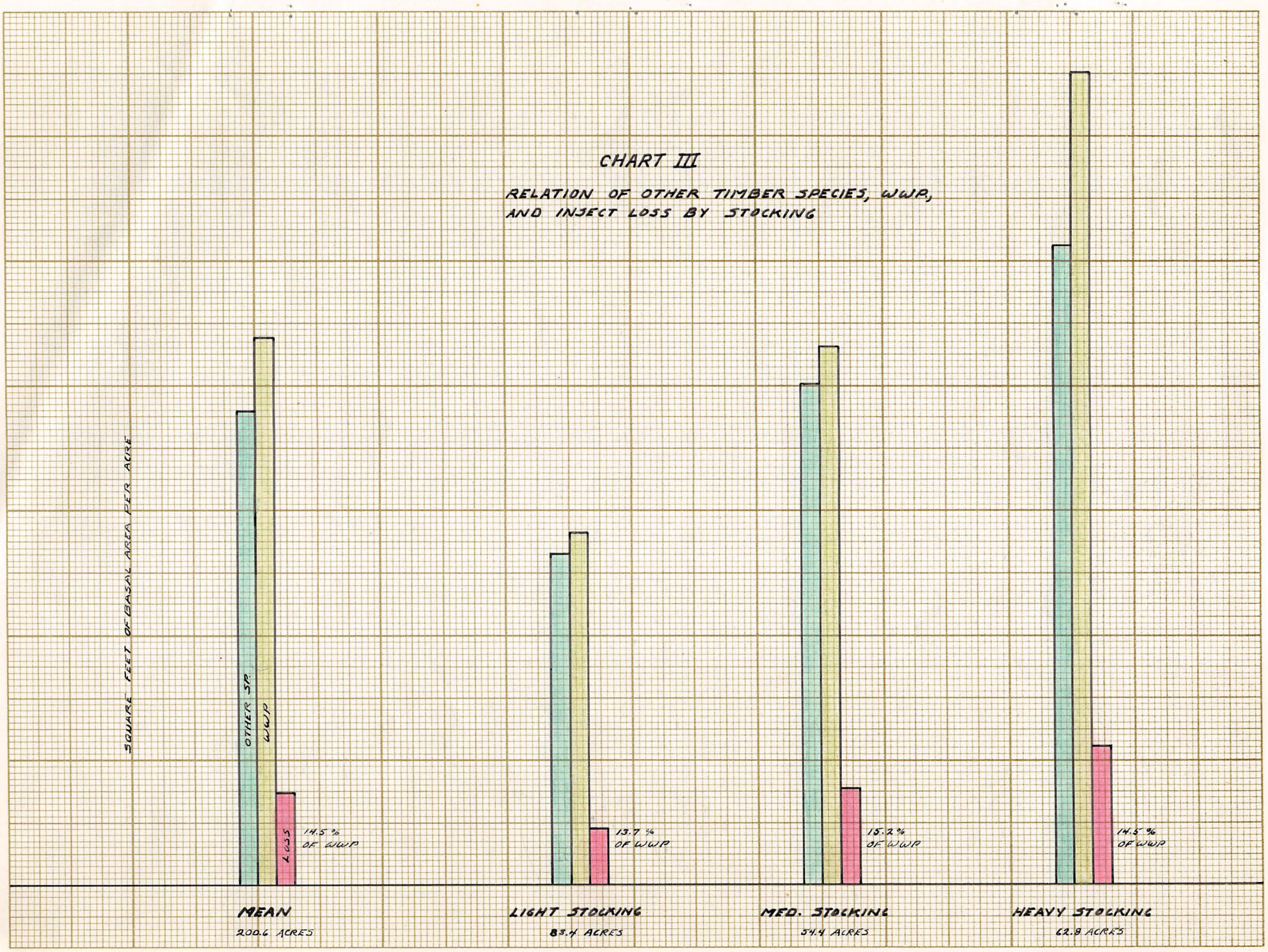
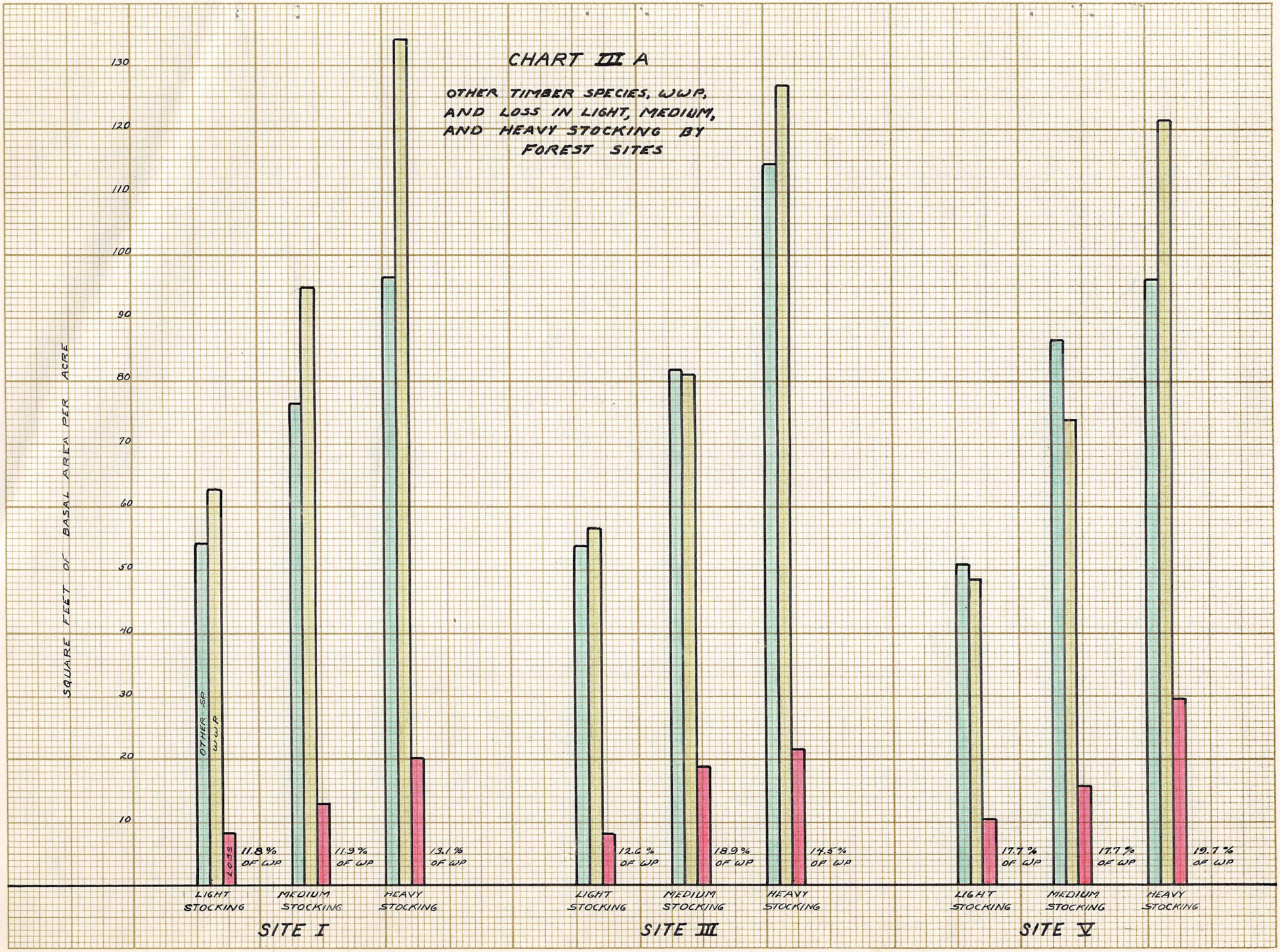


CHART III A

OTHER TIMBER SPECIES, WWP, AND LOSS IN LIGHT, MEDIUM, AND HEAVY STOCKING BY FOREST SITES



Site classifications, which include all stand ages, compositions, stockings, exposures, etc., are indicative of average forest conditions. So although better sites have produced and are carrying more wood, the loss from insect attack is not influenced by this condition. It is perhaps in error to say that insect damage is the same on all sites. Although the basal area loss is practically the same, as better sites carry a heavier stocking, the percent of loss is proportionately less. One can assume also that the transition of species is slower on better sites, which is shown in the relation of white pine to other species.

RELATION OF INSECT LOSS TO STAND AGE IN WHITE PINE AREA

From data previously submitted one can question the implied assumption that for each site and for each degree of stocking the white pine loss from insects was distributed through all age classes. This question could be based upon a possibility that although the loss data was an average for each site or stocking, it could have been limited to a few susceptible ages. The answer rests in the data as shown in chart IV, which portrays the relation of insect damage to stand ages.

The data used in this chart are a running average of three 10-year age groups. For example, the 80-90 year age group is the average of the 70 to 100-year plot ages, the 90-100 an average of the 80-110, and so on. This procedure was necessary, for although the age of each plot was determined, the age of the stand which it represented was considered as having a range of 25 to 30 years. This arrangement produced a smoother curve of both stocking and loss, which, however, did not vary greatly from the actual 10-year age class data.

Although the different age groups are presented in sequence, they portray information obtained under conditions encountered throughout the universe sampled and do not depict the history of an individual white pine stand during its development from 80 to 190 years. However, it is believed that if such data were available, they would adhere closely to the general trend as shown in this chart.

In the older age groups there is an upward trend in the basal area of mixed species, which conforms to what is considered as a normal transition of white pine. To complement this upward trend there should be a proportionate decrease in the stocking of white pine. The younger age groups show what is considered as a proper relationship of tree species, but the older groups did not conform so well. It is believed that the dip and subsequent hump in the curve of the white pine volume would be abnormal in the development of an individual white pine stand. After tolerant tree species have matched and passed the volume of white pine, it would seem that there could be no subsequent increase in the volume of the latter. However, these data are as encountered for each age class and show average stand conditions.

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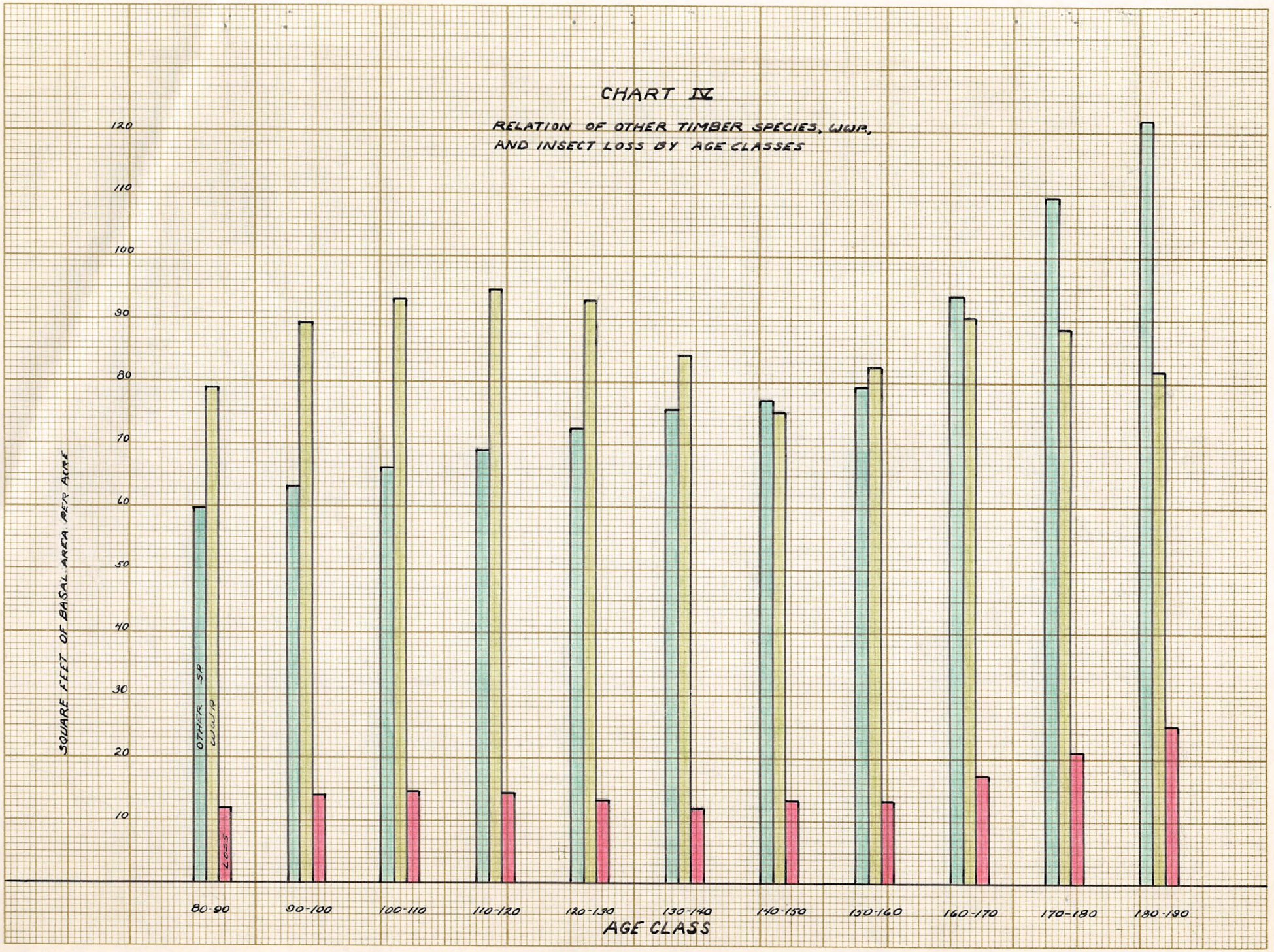


CHART IV
RELATION OF OTHER TIMBER SPECIES, WWB, AND INSECT LOSS BY AGE CLASSES
SQUARE FEET OF BASAL AREA PER ACRE
120
110
100
90
80
70
60
50
40
30
20
10
OTHER SP
WWB
LOSS
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
AGE CLASS

The rather uniform loss from insect attack is contrary to what had been expected, as it was assumed that certain age classes, as an indication of lowered resistance, would be more susceptible to insect attack than others. This condition would indicate that all age classes are represented by fully stocked stands and that loss is an adjustment for continued growth.

RELATION OF LOSS FROM INSECTS TO SITES AND STOCKING ON COEUR D'ALENE NATIONAL FOREST

As previously stated in this report, Idaho's white pine forests vary in their productiveness. Optimum conditions for the growing of white pine are considered as existing in the southern portion of the area, with less favorable conditions to the north. To avoid additional variables of "location", the past season's work was confined to the Coeur d'Alene National Forest.

Timber stand and insect loss data for the Coeur d'Alene National Forest show (chart V) the same trends as those of the entire area. The basal area of the timber stands on the Coeur d'Alene is but slightly lower than the general average of all forests. This condition was not unexpected, as the general average was influenced by an over-proportional amount of data from the Coeur d'Alene. Perhaps a comparison of stand data from the Coeur d'Alene and the southern or northern areas would show a greater difference. Attention is directed to relation of the white pine loss from insects to sites and stockings, which is comparable to the data obtained from all areas.

Losses from insect attack and average timber stands for each age class on the Coeur d'Alene Forest are shown in chart VI. It should be restated that these data do not depict the history of a white pine stand during a period of its development, but are conditions encountered for the different age groups. These data are quite similar to those obtained from all forests (chart IV) except that the green stand volume is slightly lower. There is also a variance in the white pine stocking of the 160-170 and 170-180 age classes. The upward trend of the Coeur d'Alene data is a departure from what was assumed as being a more normal picture. There are some slight differences in volume of white pine killed by insects; however, the same general trend prevails with no great variation for different age groups.

RELATION OF INSECT LOSS TO STAND DATA FROM SMALL AREAS

Data have been presented showing averages of specific stand conditions for the entire universe sampled. Similar averages of conditions on the Coeur d'Alene National Forest showed the same general trends. To eliminate the variable of stand age, and to see if the same relationships would prevail for smaller areas, data from a portion of the Coeur d'Alene Forest follow.

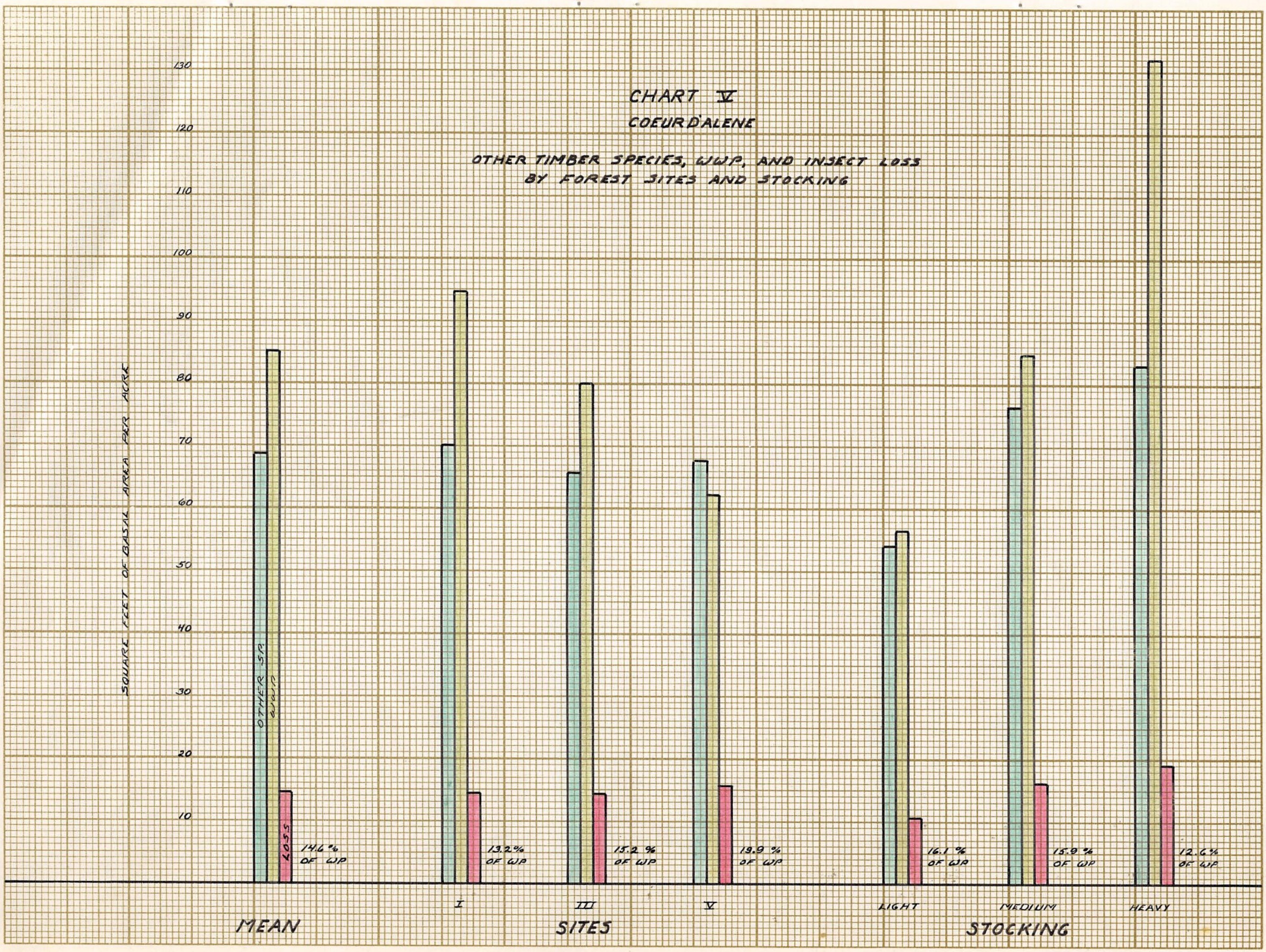
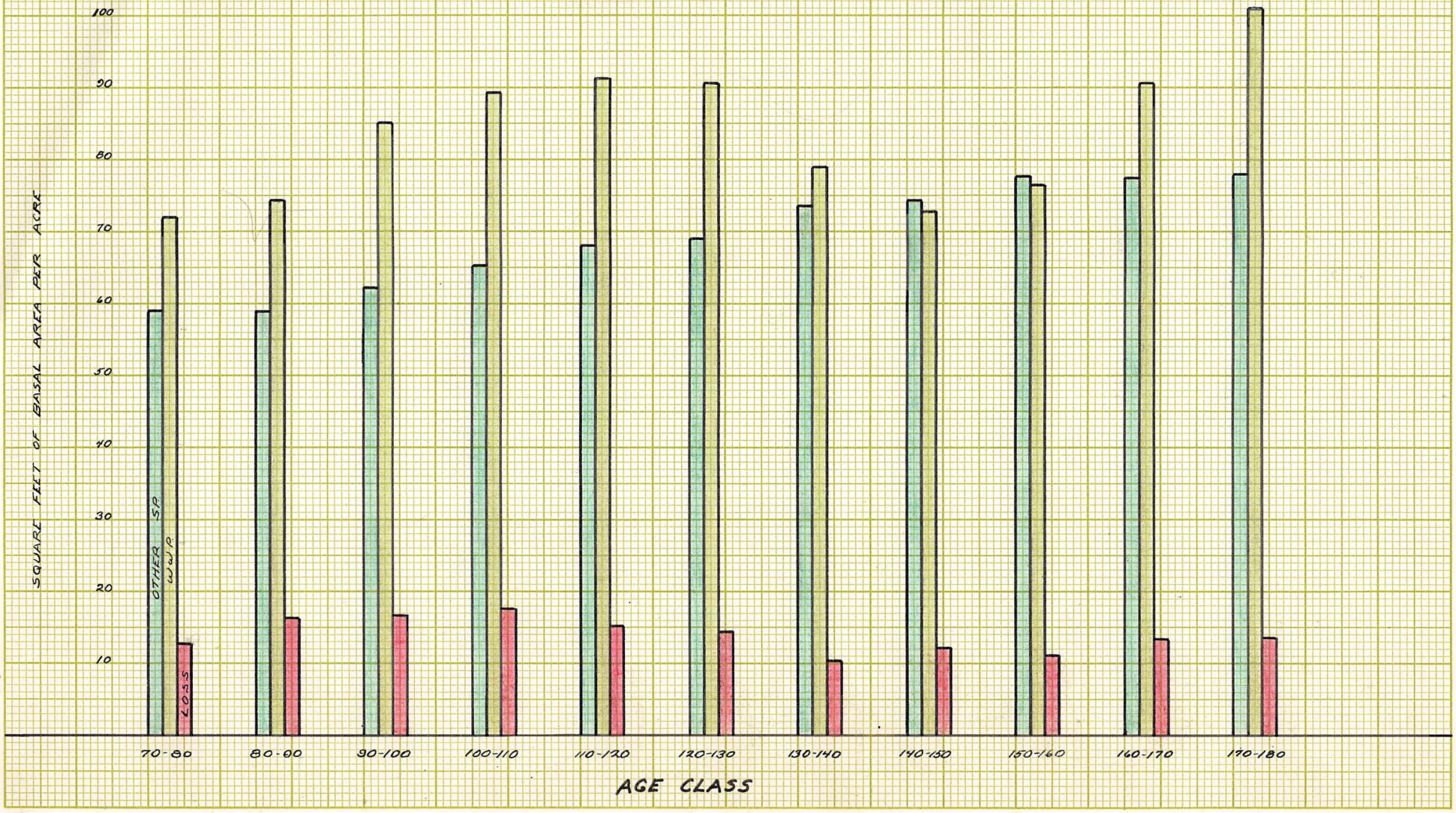


CHART V
COEUR D'ALENE
OTHER TIMBER SPECIES, WWP, AND INSECT LOSS
BY FOREST SITES AND STOCKING
SQUARE FEET OF BASAL AREA PER ACRE
130
120
110
100
90
80
70
60
50
40
30
20
10
OTHER S/P
WWP
LOSS
14.6 % OF WP
13.2% OF WP
15.2 % OF WP
19.9 % OF WP
16.1 % OF WP
15.9 % OF WP
12.6% OF WP
I
III
V
LIGHT
MEDIUM
HEAVY
MEAN SITES
STOCKING

MADE IN U. S. A.

CHART VI

RELATION OF OTHER TIMBER SPECIES, WWP, AND INSECT LOSS BY AGE CLASSES COEUR D'ALENE FOREST



Yellow Dog and Downey Creek - Coeur d'Alene National Forest

The Yellow Dog and Downey Creek drainages are adjacent to each other and are quite similar as to timber stand, environmental conditions, and past insect damage. Although these timber stands were considered as even-aged, the scattergraph on the left of chart VII portrays the variation in the 223 plots from which the data were obtained. Of these, 33 were of 1 acre in area and 190 of 1/5 acre. Although there is a distinct grouping of plots around the established mean of 106.3 years, the standard deviation of individual plots would be large. This variation of age classes in an area of this size is not an abnormal occurrence.

Although it would be expected that data from such small areas would vary somewhat from those of a larger universe, the same general trends persisted. The actual loss from insect attack corresponds quite closely to the average figures for all forests.

Sissons Unit - Coeur d'Alene National Forest

Although fully adequate data were not available for this small unit, they are presented in chart VIII to show the persistence of the same general trends. There are some variations in stocking and loss from insects, which are no doubt peculiar to this area.

SUMMARY DISCUSSION OF DATA

Our data show no variation in the loss of white pine from insect attack for different-aged stands. Although an indirect relationship was expected, there is no reason why age, by itself, should influence the susceptibility of forest trees to insect attack. Maturity, vigor, and susceptibility may be related, but age does not determine maturity. Aside from accident and mechanical limits of accumulated growth, such woody plants as forest trees should be almost immortal.

Although vigor and susceptibility are considered as being closely related, one must not assume that good sites always produce resistant trees. This position is based upon the fact that although more wood is produced, competition may be just as severe as on poorer sites. As site classifications, which are gradations of soil capacities, include all other stand variables, it can be assumed that with the exception of wood volume they represent an average forest condition. It can be assumed also that most white pine stands are fully stocked and overtaxing the wood-producing capacity of the soil.

SCATTERGRAPH
SHOWING SPREAD OF AGE BY PLOTS

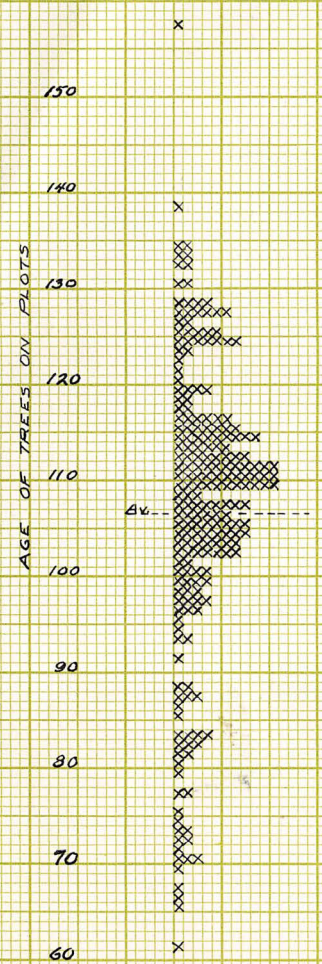
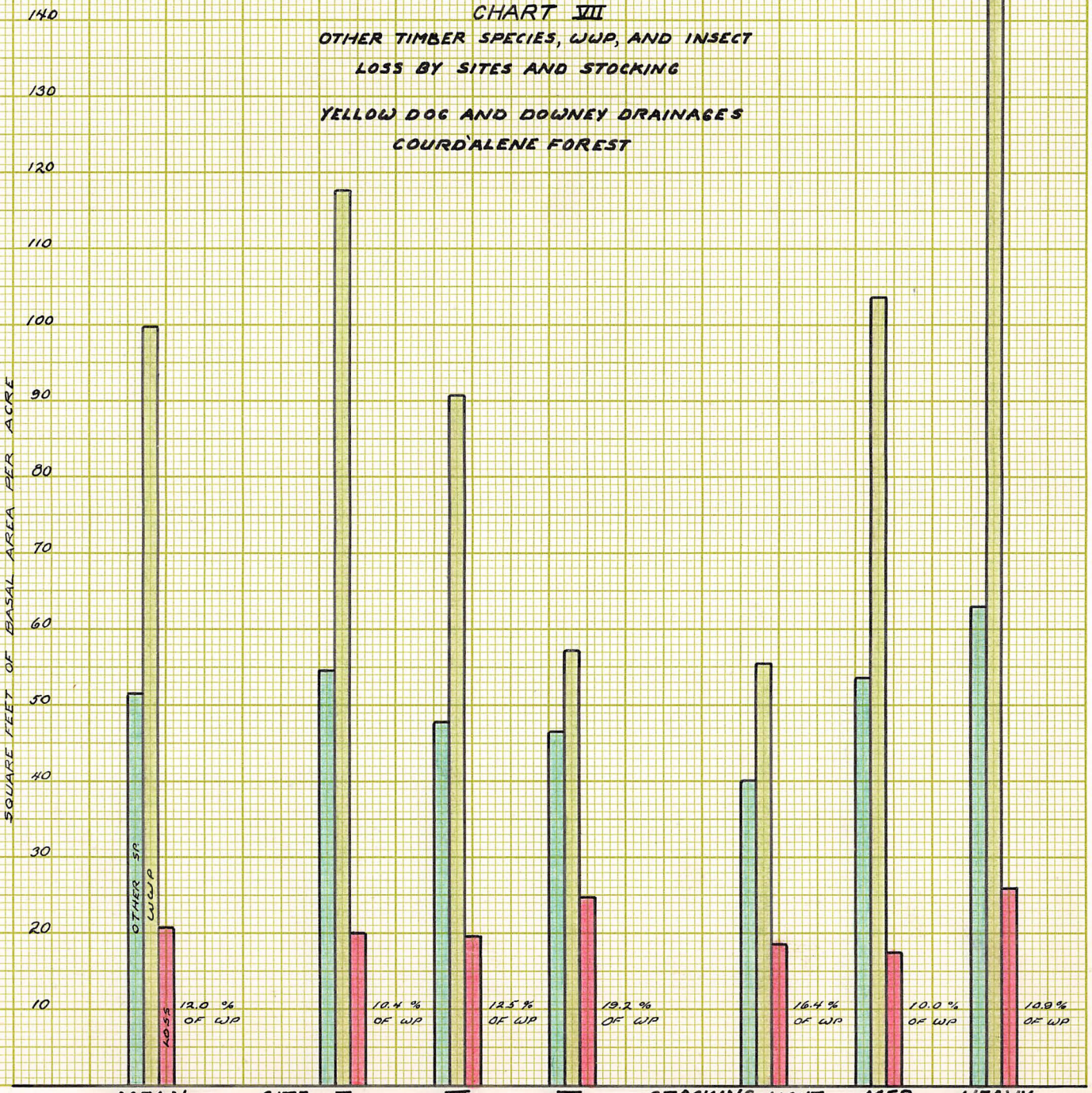


CHART VIII
OTHER TIMBER SPECIES, WJP, AND INSECT LOSS BY SITES AND STOCKING
YELLOW DOG AND DOWNEY DRAINAGES
COUR D'ALENE FOREST

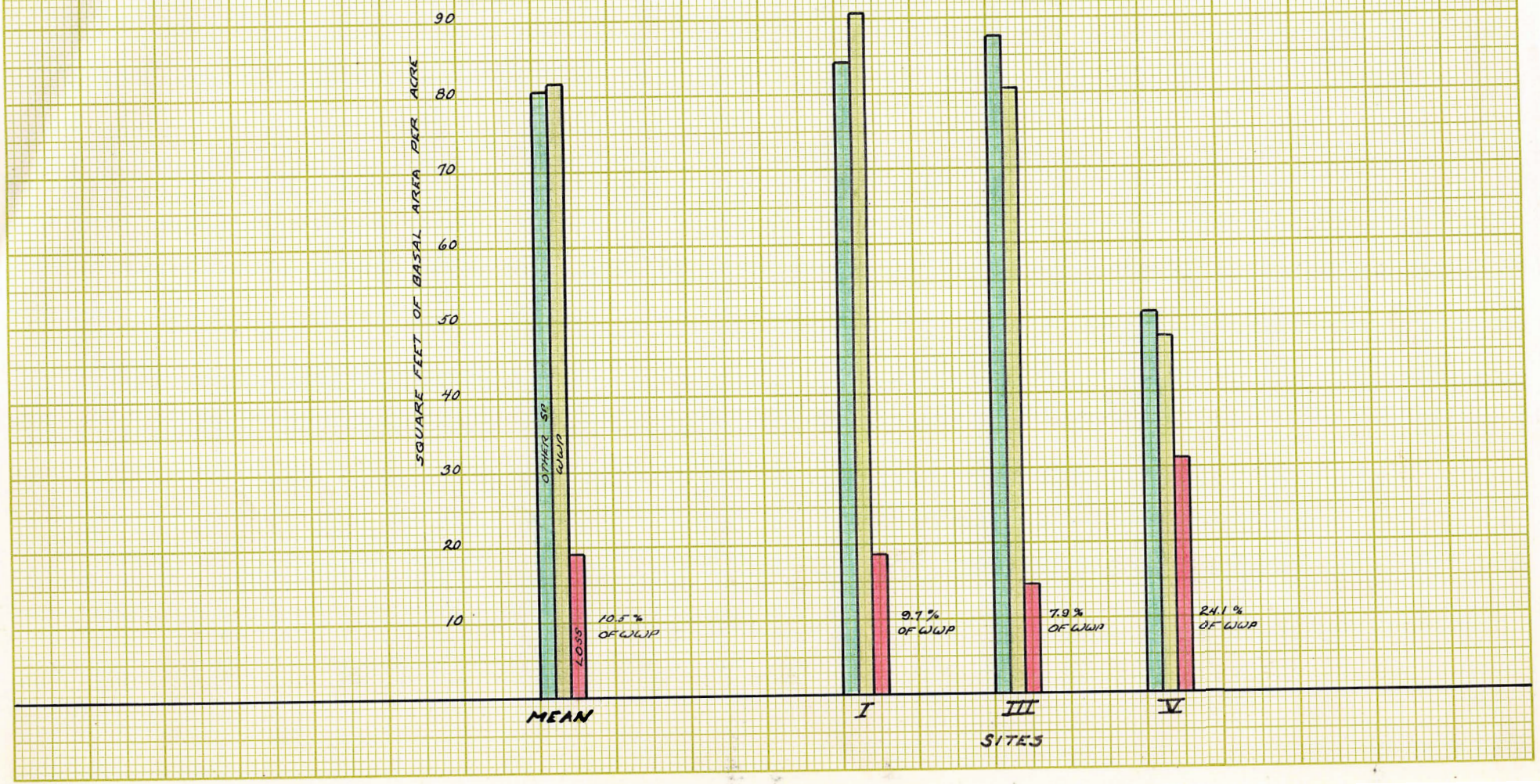


MADE IN U. S. A.

CHART VIII

OTHER TIMBER SPECIES, WWP, AND INSECT LOSS BY SITES

SISSON'S AREA COEURD'ALENE FOREST



The correlation between the loss of white pine and stocking would seem to support a position of stand adjustment to the wood-producing capacity of soils. Although the actual volume destroyed increased proportionately with increased stocking, the percent of white pine destroyed remained practically the same. As a result it would seem that the greatest volume loss will occur in the heaviest pine stockings but that the percent of white pine stand destroyed will be about the same for all areas. It is also quite possible that the loss is but the overgrowth of that particular site.

Although an unsuccessful attempt was made to show some correlation between different stand compositions and insect loss, the importance of this factor is still questioned. It is believed that in some instances, perhaps younger stands, composition can be considered as an index of subsequent white pine loss. Such a relationship could rest in the competition of different tree species, or specific stand compositions could indicate an unfavorable environment for the growing of white pine.

These complex relationships are simplified by remembering that eventually white pine will pass from such temporary forest types. When the volume of the associated tree species equals and then exceeds that of white pine, the regression of the latter species is occurring. Although the actual volume of pine may hold at an existing level for a period of years, the competition continues and eventually only the tolerant primary tree species survive. The many factors involved in this transition do not permit a definite period to be set for the occurrence of such ecological events. In some areas stockings of white pine have given way to other species at an early age. In other instances heavy stockings of white pine attain ages of 250 years and more.

For a number of years we have considered the dying of young white pine on specific areas as but a question of the wood-producing capacity of the soil, with the ultimate survival of the most hardy species. We now feel that the same answer can be used, in moderation perhaps, to explain the loss from insects in merchantable timber stands. Perhaps we have been loath to believe that there is a natural, or normal, succession of white pine in stands as young as 60 or 70 years. Perhaps we have failed to realize that most of our white pine stands are overstocked, not understocked as we wanted to believe. It is true that our data show an increased basal area for older stands, which seems to belie the premise of overstocking. These basal area figures are not entirely significant, as they include only trees of 5 inches or more in diameter. Furthermore, basal area or volume is but the wood that has been produced over a variable period of years, while annual growth is a measure of wood-producing capacity. It is obvious that although the total volume, or basal area, will be less, the wood that is produced each year in timber stands of 70 or more years will because of the

greater number of trees equal or exceed that of older mature forests. This relation of growth to age was shown by Haig in 1932*.

If the total annual production of wood could be distributed throughout an ideally stocked stand, an optimum growth should occur in all trees. When the same growth is distributed through an overstocked area, it will not be equally distributed and some trees will show far less increment than others. As this competition continues, such trees will become less vigorous, decadent, and supposedly more susceptible to bark beetle attack. In areas where growth has been materially reduced through overstocking, an accumulation of potentially susceptible trees occurs. Such accumulations could be responsible for the development of bark beetle epidemics, and in the destruction which follows many trees killed beyond the existing realm of susceptibility.

Unfortunately so-called thinning by bark beetles affords to residual stands but little relief from the inevitable competition of other species. Insects are poor lumbermen and do not select trees in accordance with approved forestry practices. Not only are low-vigor trees destroyed but associated thrifty individuals are attacked. Group killings leave openings in forest canopies which are soon filled with secondary tree species. So competition which marks the normal succession of white pine is to be removed and a near pure pine stand preserved, stocking must not overtax the wood-producing capacity of soils. Under such conditions it is believed that white pine could compete successfully against shade-tolerant species. It is further believed that rather pure stands of white pine can be made practically permanent through proper cultural methods.

At the present time we must use artificial control measures to prevent the development of destructive bark beetle outbreaks which in a few years destroy large volumes of valuable timber. Such action is but a temporary expedient and offers no assurance that subsequent outbreaks will not occur. On the other hand, the removal of the forest condition which contributes to such destructiveness would eliminate the necessity for direct control. Furthermore, such intensive forest practices would permit maximum crops of white pine to be grown in a minimum of years.

Such intensive methods for the growing of white pine may be too far in the future to be of much service in solving our immediate problem. However, if unsatisfactory forest conditions are recognized, steps can be taken to meet the problem which they present. Timber stands can be classified as to their susceptibility, and the most vulnerable

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* Haig, I. T. Second Growth Yield, Stand, and Volume Tables for Western White Pine Type. U. S. Tech. Bull. No. 323.

logged ahead of others. Such cutting can be in accordance with existing plans of management, varying from clear cuts to a selection of low-vigor or susceptible trees. Selection cutting, if found to be economically practical, is considered as offering a possible solution to our problem If thrifty trees can be freed from competition through the removal of susceptible individuals, insect losses should be reduced to a minimum and a greater volume of white pine made available for subsequent cutting.

During the coming season our work will be confined to the study of a rather small unit on the Coeur d'Alene National Forest. There are already considerable plot data available for this area, and its entomological history for the past 13 years is well known.

From our explorations in this field we have learned a great deal concerning the losses of white pine as a result of mountain pine attack. Perhaps some of this information we should have known before, as it seems quite obvious at this time. Perhaps this is always true.